Tidal Potomac PCB TMDL

Public Meetings

July 17 – ICPRB, Rockville, MD
July 17 – Public Library, LaPlata, MD
July 18 – MWCOG, Wash., DC
July 19 – VA DEQ, Woodbridge, VA

Carlton Haywood
Interstate Commission on the
Potomac River Basin

1) Potomac PCB TMDL: Scope, Approach, & Schedule

Tidal Potomac & Anacostia R. water bodies listed as impaired due to high PCBs

Virginia

In most embayments, the impairment covers all tidal waters.

Accotink Creek
Aquia Creek
Belmont Bay
Chopawamsic Creek
Coan River
Dogue Creek
Fourmile Run
Gunston Cove
Hooff Run
Hunting Creek
Little Hunting Creek
Monroe Creek/Bay
Neabsco Creek
Occoquan River
Pohick Creek
Potomac Creek
Powells Creek
Quantico Creek
Up. Machodoc Cr.

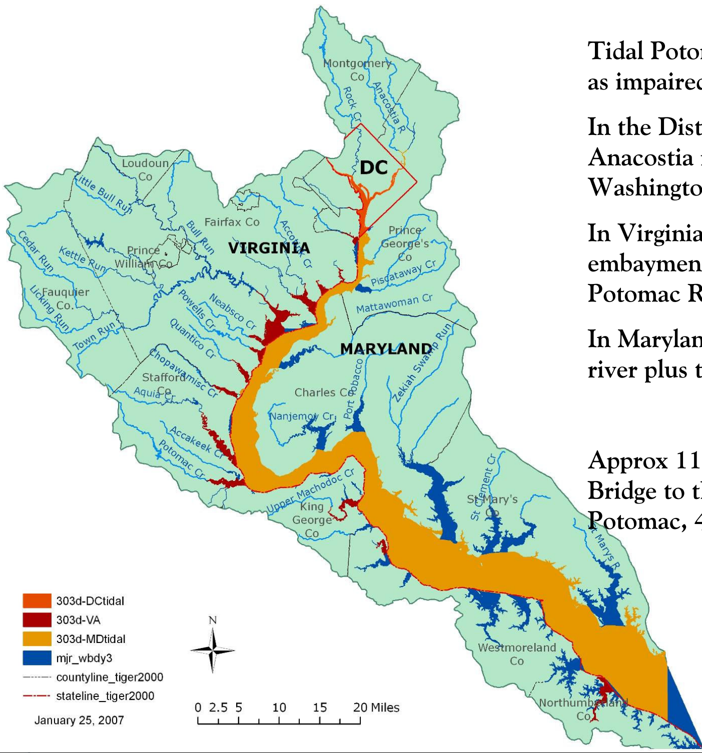
Potomac R. (Fairview Beach, King George Co.)

Maryland

Upper Tidal Potomac R.
Middle Tidal Potomac R.
Lower Tidal Potomac R.
Tidal Anacostia R.

District of Columbia

Upper Potomac R.
Middle Potomac R.
Lower Potomac R.
Upper Anacostia R.
Lower Anacostia R.



Tidal Potomac water bodies listed as impaired for PCBs in fish tissue.

In the District of Columbia, the Anacostia river, the Potomac river, Washington Ship Channel.

In Virginia, 19 separate embayments & one section of Potomac R.

In Maryland, the tidal Anacostia river plus the mainstem Potomac

Approx 117 miles from Chain Bridge to the mouth of the Potomac, 457 mi^2 tidal waters.

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How we got here:

1) From 1996 to 2006, based on monitoring, DC, MD, and VA put various tidal Potomac & Anacostia water bodies on their 303(d) lists because **PCBs concentrations in fish** exceeded thresholds which meant that the **Fish Consumption Designated Use was impaired.**

2) Clean Water Act requires that a Total Maximum Daily Load study be done to:

   a) **determine the maximum load to the water body at which the Designated Use is restored.**

   b) allocate that maximum load to sources.

How we got here:

3) District of Columbia has a court ordered deadline of September 30, 2007 to complete their tidal Potomac PCB TMDL.
4) MD, VA, ICPRB and EPA, decide to work with DC to complete PCB TMDL for all tidal waters by Sep., 2007, using common methodology, because:
   a) Impaired waters are adjacent to each other and loads move between impairments.
   b) Joint TMDL more cost effective to develop.
   c) Three independent TMDL studies using potentially different models and assumptions and load allocations would be difficult, perhaps impossible, to reconcile.

TMDL Development Schedule

• Compile historical data	2005
• Select modeling framework	2005
• New PCB samples in water, sediment, & WWTPs	2005-2006
• Hydrodynamic / Salinity Model completed	Feb 2006
• 1st Round Public Stakeholder Meetings	Jun 2006
• Interim version of PCB model	Feb 2007
• Draft loading summary document	Jan 2006
• Final validated PCB model	Jun 2007
• Final report on PCB model calibration	Jul 16, 2007
• Draft TMDL report for public review	Jul 17, 2007
• 2nd Round public stakeholder mtgs	Jul 17-19, 2007
• TMDL comment period	Jul 17 – Aug 16
• TMDL report submitted to EPA (approx)	Sep 7, 2007
• EPA approval of TMDL	Sep 30, 2007

PCB TMDL is based on

1) Data

-- ambient conditions

-- loads

-- targets

2) External Loads

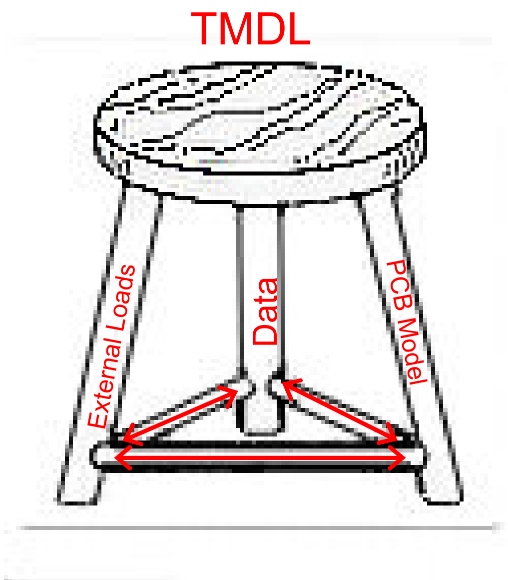
-- sources & magnitudes

3) PCB Model

-- calibrate to ambient

-- transport & fate of sources

-- predict [PCB] for reduced loads

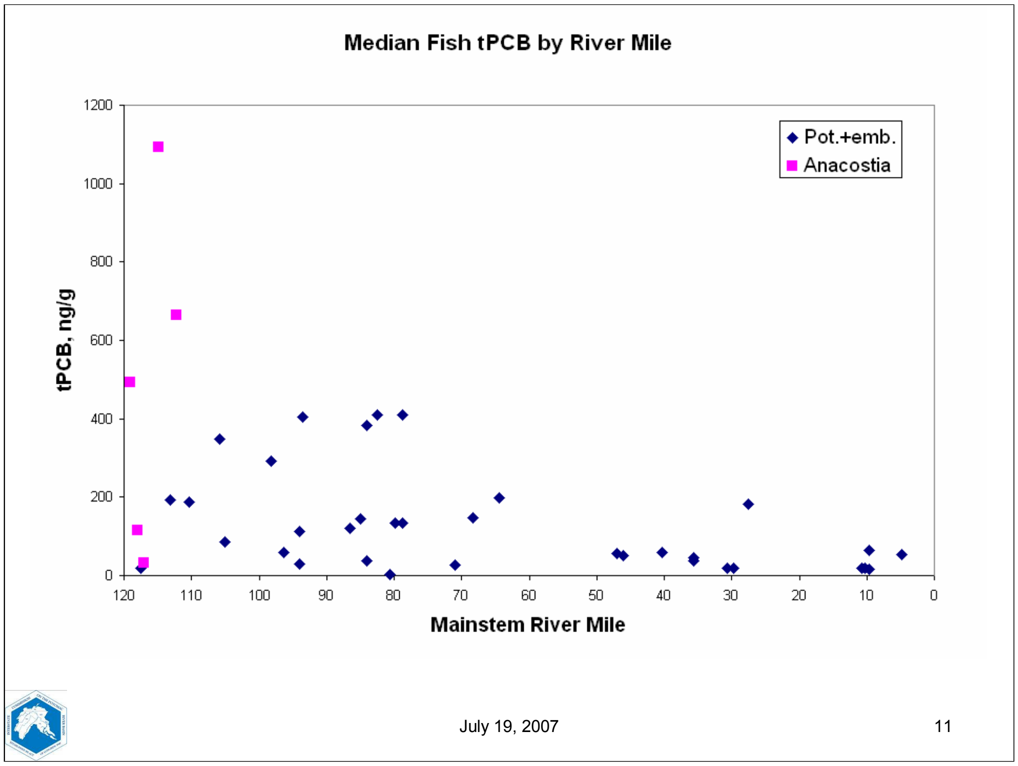


1) Ambient Data

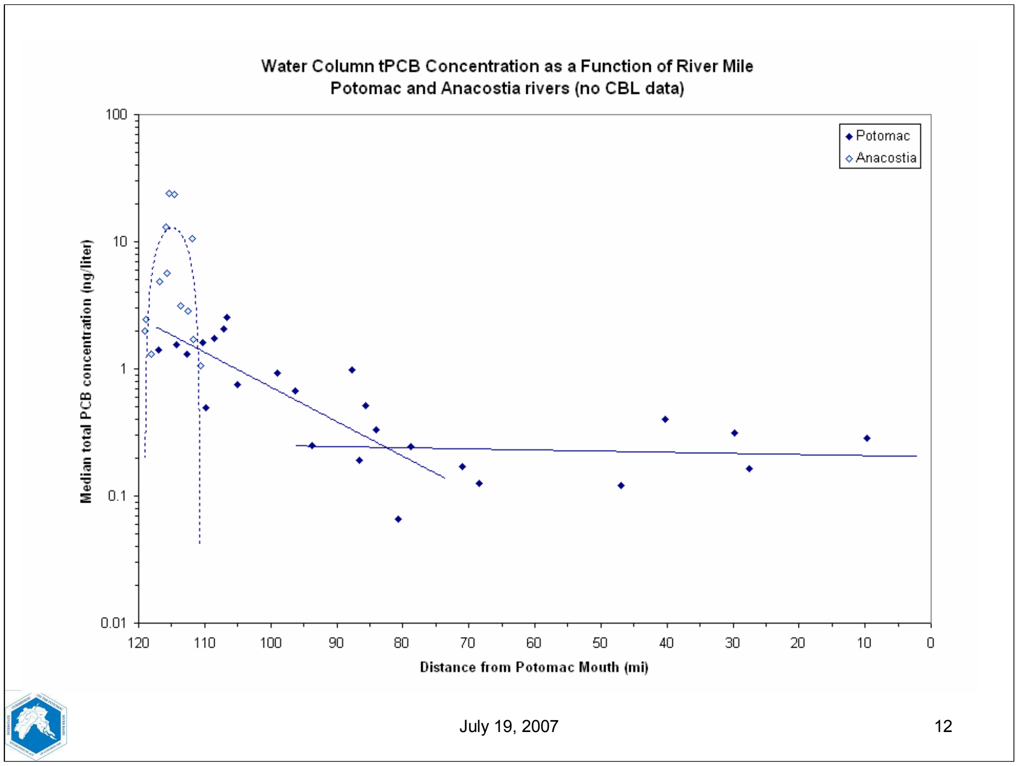
State waterbody impairment criteria.

Both Fish Tissue Thresholds and WQ Standards apply.

	Fish Tissue Impairment Threshold (ppb)	Water Quality Standards (ng/l)
Dist. of Col.	20	0.064
Maryland	88	0.64
Virginia	54	1.70
	* Specific reason for 303(d) listing.	



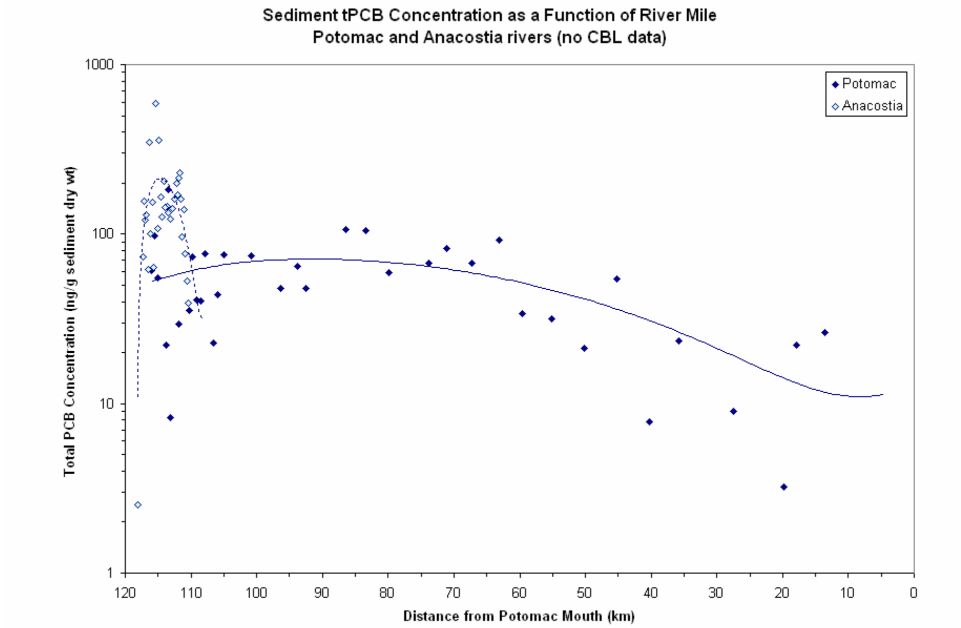
Compare these values to the fish thresholds from previous slide.



Note log scale on Y axis

Note these are ambient (tidal) samples only. Chain Bridge & other trib data not included.

Compare values with state WQS.



Sediment tPCB Concentration as a Function of River Mile
Potomac and Anacostia rivers (no CBL data)
Total PCB Concentration (ng/g sediment dry wt)
Distance from Potomac Mouth (km)
Potomac
Anacostia
1000
100
10
1
120
110
100
90
80
70
60
50
40
30
20
10
0

July 19, 2007

Summary Ambient Data Findings

- Highest values (fish, water, sediment) in Anacostia river.
- Water, sediment values in Potomac declining gradually downstream.
- Variability of several hundred percent in nearby sites.
- 2-3 orders of magnitude variation from top of estuary to bottom.
- Fish exceeding concentration thresholds throughout estuary.
- Fish exceeding thresholds even in areas where water samples do not exceed WQS.

2) Estimating PCB Source Loads

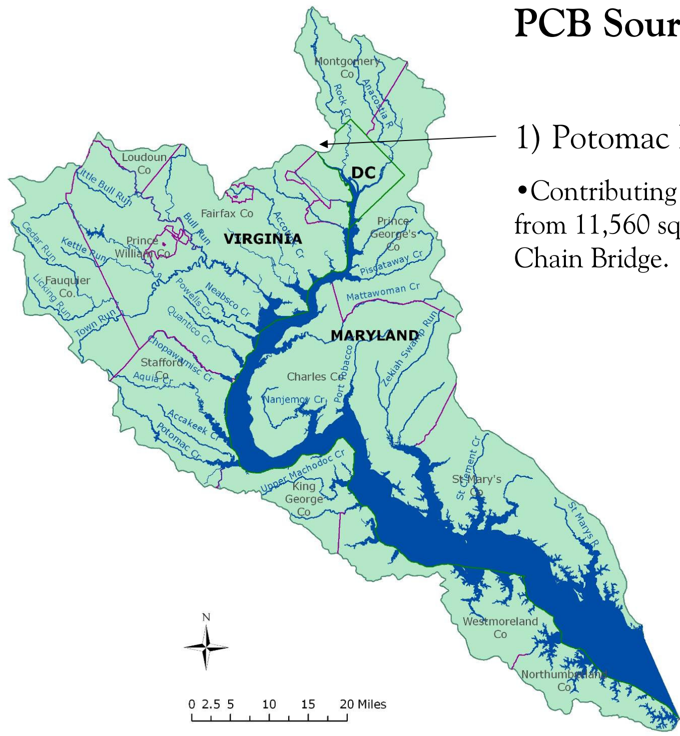
PCB External Source Categories

1) Tributary input
   a) Potomac River
   b) Other tributaries
2) Direct Drainage (Non Point Source)
3) Contaminated Sites
4) Atmospheric deposition
5) Point Sources
6) Combined Sewer Overflows (CSO)

PCB Load Estimation Methods

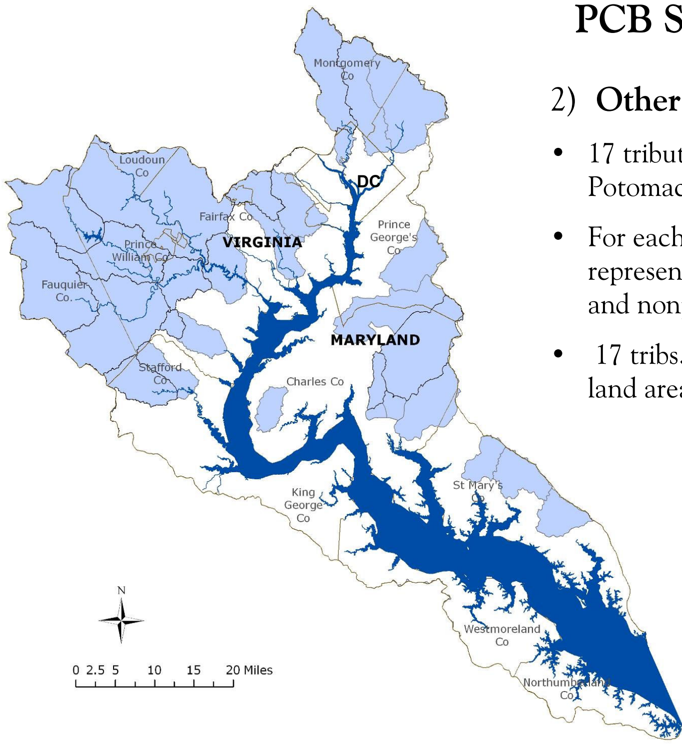
- **Potomac River at Chain Bridge**
  - Flow = daily USGS gage flows
  - [PCB] = f(TSS), TSS = g(flow) regression model specific to Chain Bridge
- **Other Tribs, Direct Drain:**
  - [PCB] =f(TSS), TSS and flow estimated by CBP Watershed Model.
  - Different PCB:TSS relationships depending on distance, "PCB Loading Zones", from DC.
- **CSO:**
  - Very limited data, so [PCB]=f(TSS), DCUrban loading zone,
  - Constant TSS based on median from 2002-2005 sample programs,
  - Daily flow simulated by MOUSE and SWMM models.
- **Point Source:**
  - [PCB]= site specific mean of samples collected, flow based on DMRs.
- **Atmos. deposition:**
  - Mid '90s field study and literature based. PCB deposition at a constant daily rate in 3 deposition zones, .
- **Contaminated Sites:**
  - Compute annual soil loss w/ RUSLE2. Multiply soil loss by [PCB] obtained from site specific soil samples. Annual loss rate converted to constant daily value.

PCB Source Categories



1) Potomac River at Chain Bridge

•Contributing water and associated loads from 11,560 sq. mi. watershed upstream of Chain Bridge.



PCB Source categories

2) **Other Tributaries**

- 17 tributaries in addition to Potomac at Chain Bridge
- For each tributary, one load representing the sum of all point and nonpoint sources, is computed.
- 17 tribs. comprise about 44% of land area below Chain Bridge.

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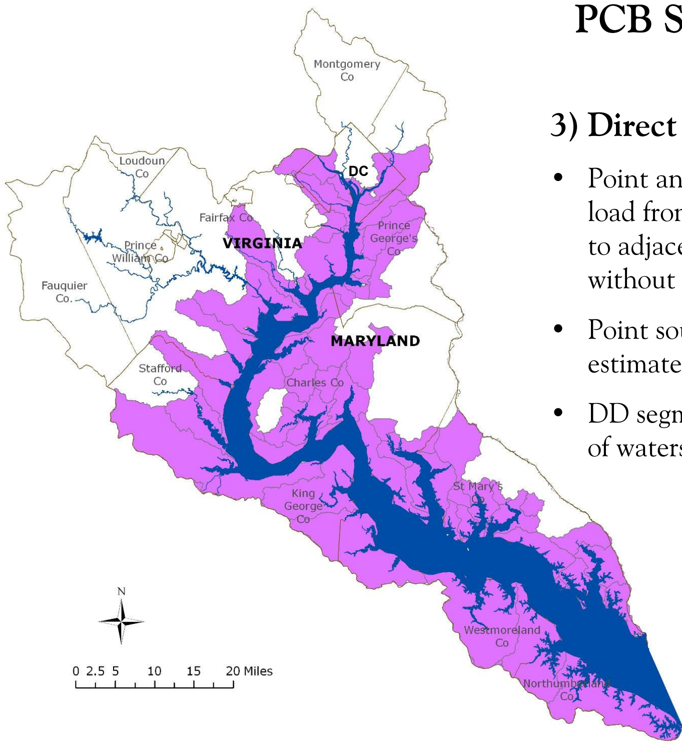
PCB Source categories



3) Direct Drainage areas.

- Point and nonpoint source flow and load from all DD area is delivered to adjacent estuarine model cells without decay or time lags.
- Point sources are individually estimated.
- DD segments comprise about 56% of watershed land area.

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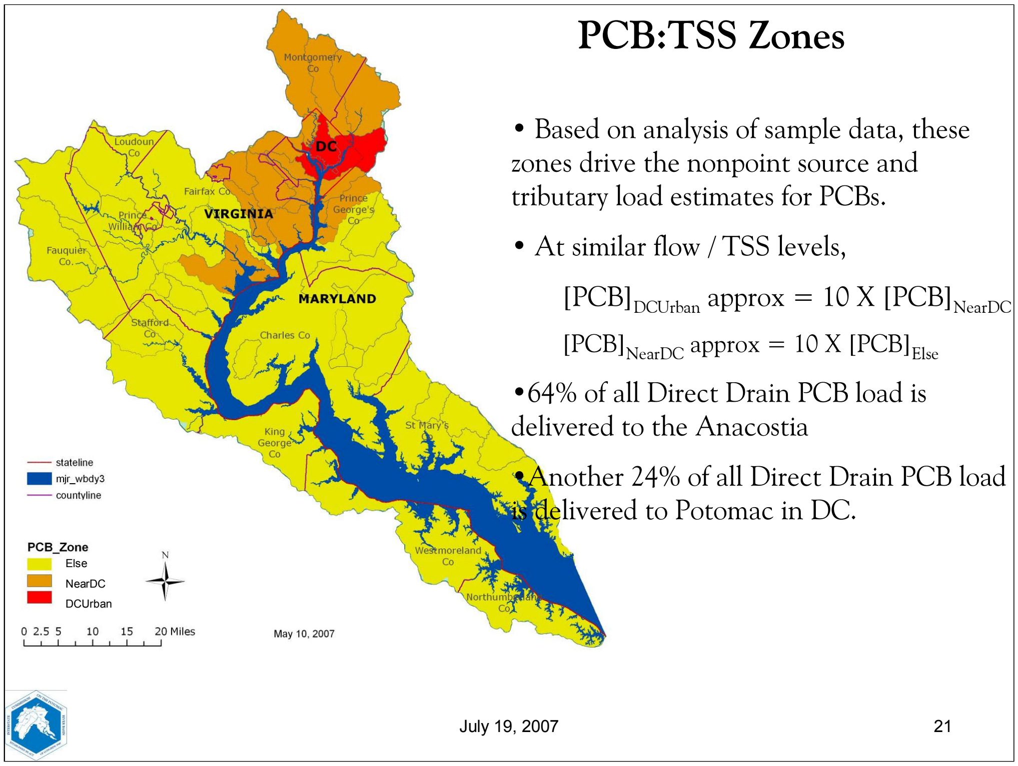
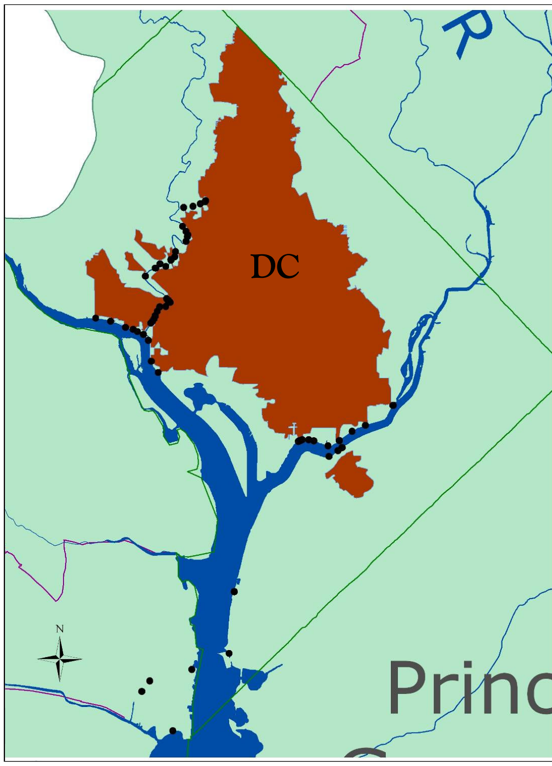


Daily estimates of [PCB] from tributaries and from direct drain watersheds are derived from regressions of [PCB] and [TSS] in different regions.

Existing data reveal distinct differences in [PCB] : [TSS] relationships between regions.



PCB Source categories

4) Combined Sewer Overflows

- 56 CSO outfalls, 12,750 acres, in DC on Anacostia, Rock Creek, and Potomac River.
- 4 CSO outfalls in Alexandria
- CBP Watershed Model has CSO watershed defined in DC in which all runoff presumed to go into CSO system.

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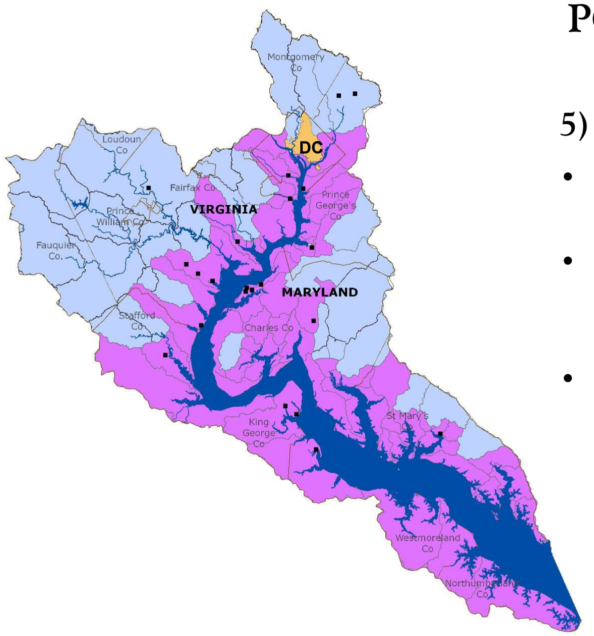
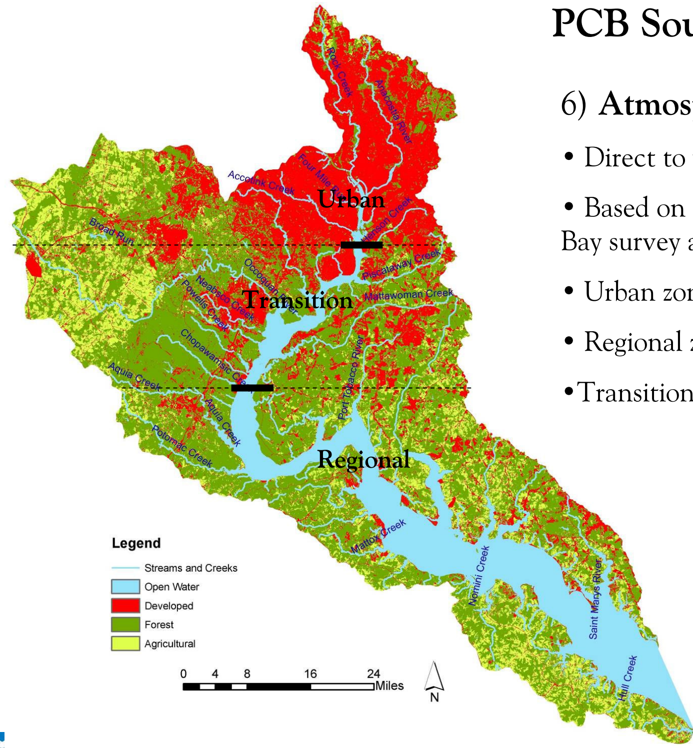


PCB Source categories

5) Point Sources

- Flow & load from 20 WWTPs input to model.
- These 20 comprise 95% of flow from all WWTPs in the watershed.
- Three additional WWTPs in trib. watershed are being tracked.



PCB Source categories

6) **Atmospheric Deposition**

- Direct to water surface only
- Based on mid '90s Chesapeake Bay survey and literature review.
- Urban zone 16.3 ug/m2/yr tPBC
- Regional zone 1.6 ug/m2/yr tPBC
- Transition zone interpolated

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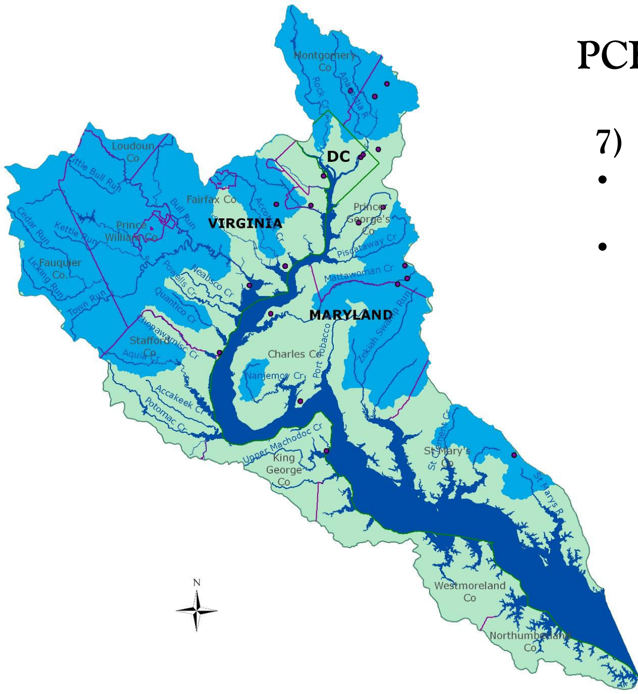


PCB Source categories

7) Contaminated Sites

- 13 sites contribute load to model
- 8 additional sites in trib. watersheds loads calculated an tracked (load implicit in trib.)

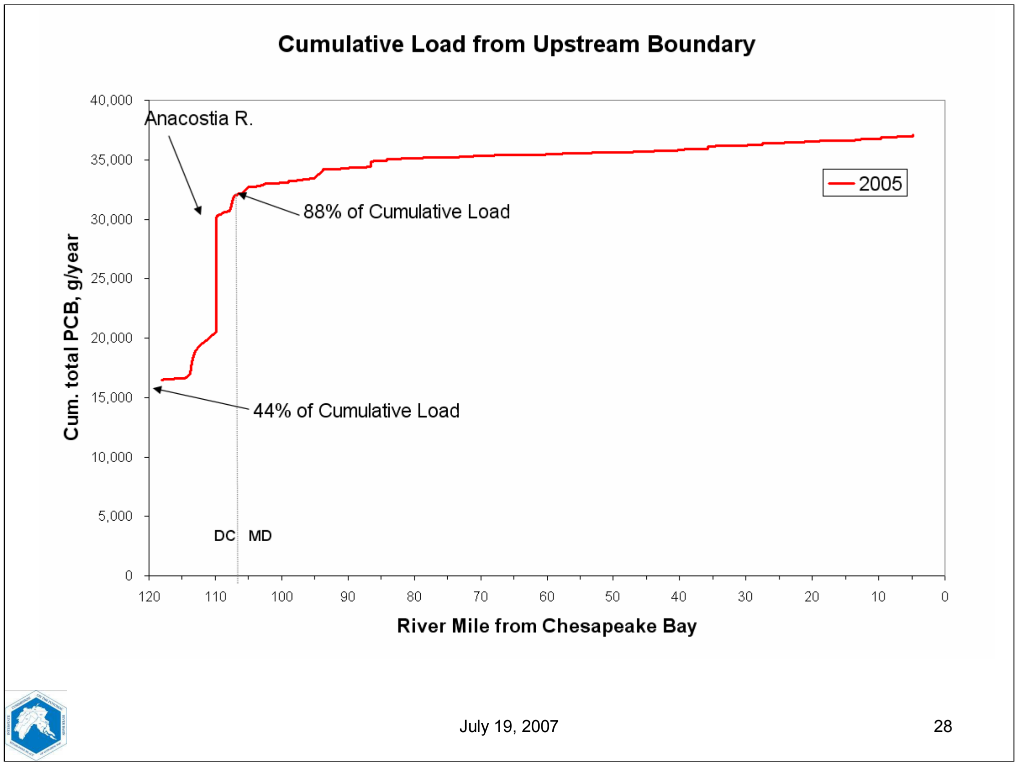
Critical condition and Base Year

Selecting a base flow year.

- EPA guidance and state regs recommend using harmonic mean flow for pollutants whose health impact is due to long term exposure.
- Data availability, required for calibration purposes, restricts our options to sometime in period 2002-2005
- Calendar 2005 closest to long term harmonic mean.
  - 1931-2005 harmonic mean flow: 4,760 cfs
  - Calendar 2005 harmonic mean: 5,485 cfs

PCB Load estimates for 2005 Base year

	g/yr total PCB	%
Potomac R @ Chain Bridge	16,400	44 %
All other Tribs.	2,660	7.7%
Sum all Direct Drain Area	10,900	29 %
Combined Sewer Overflow	3,020	8.2%
Point Sources	761	2.1%
Atmospheric Deposition	3,070	8.3%
Contaminated sites	15	0.04%
Total	37,070	100 %



This cumulative load plot provides insight into the geographic distribution of load inputs to the tidal system.

Summary Source Loads Findings

- Potomac River @ Chain Bridge 44% of total external load
- Chain Bridge + direct drain source category contribute almost ¾ total load.
- Almost 90% of total external load enters system upstream of DC/MD border on Potomac.
- Not shown in these slides but note that a large fraction of total annual load from Chain Bridge, other tributaries, direct drain, and CSO are driven by high flow events on relatively few days.
- Blue Plains WWTP accounts for 90% of point source category,

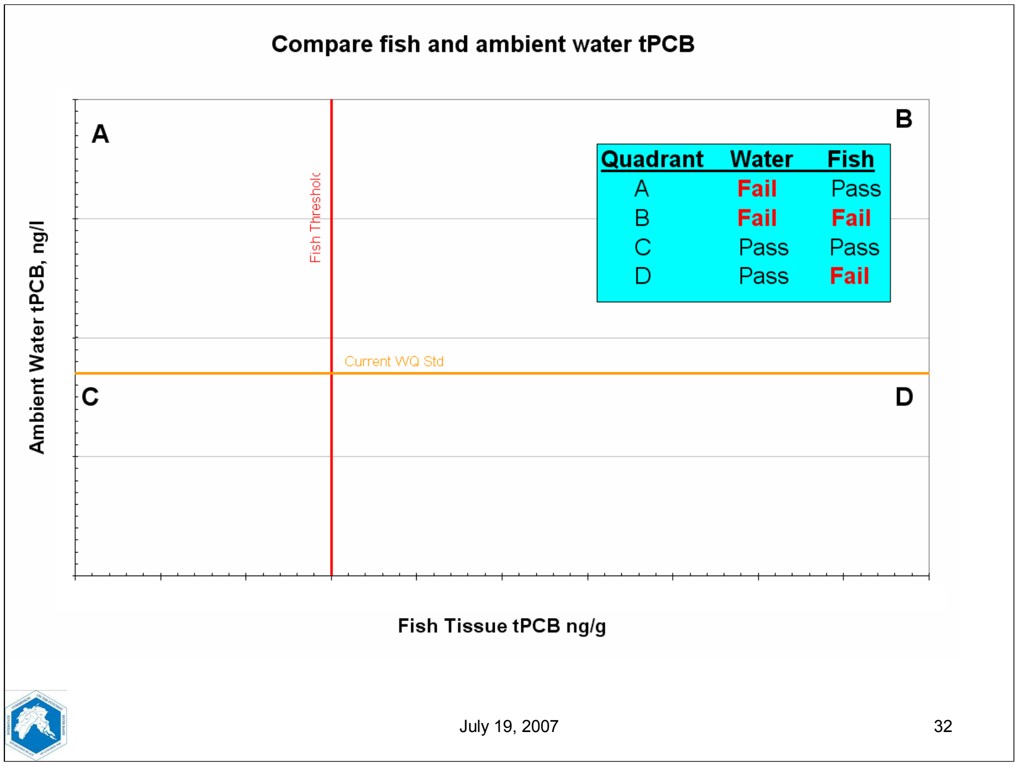
Selecting Water / Sediment target concentrations

1) Fish consumption is the designated use that is impaired.
2) TMDL must show that the reduced loads will correct the impairment.
3) PCB model, however, predicts PCBs in water and sediment, but not fish.
4) Need to determine functional relationship between PCBs in Water & Sediment and in Fish.

Method for determining water target

- Associate fish, water, and sediment samples
- Calculate bioaccumulation factor (BAF), per EPA guidance,

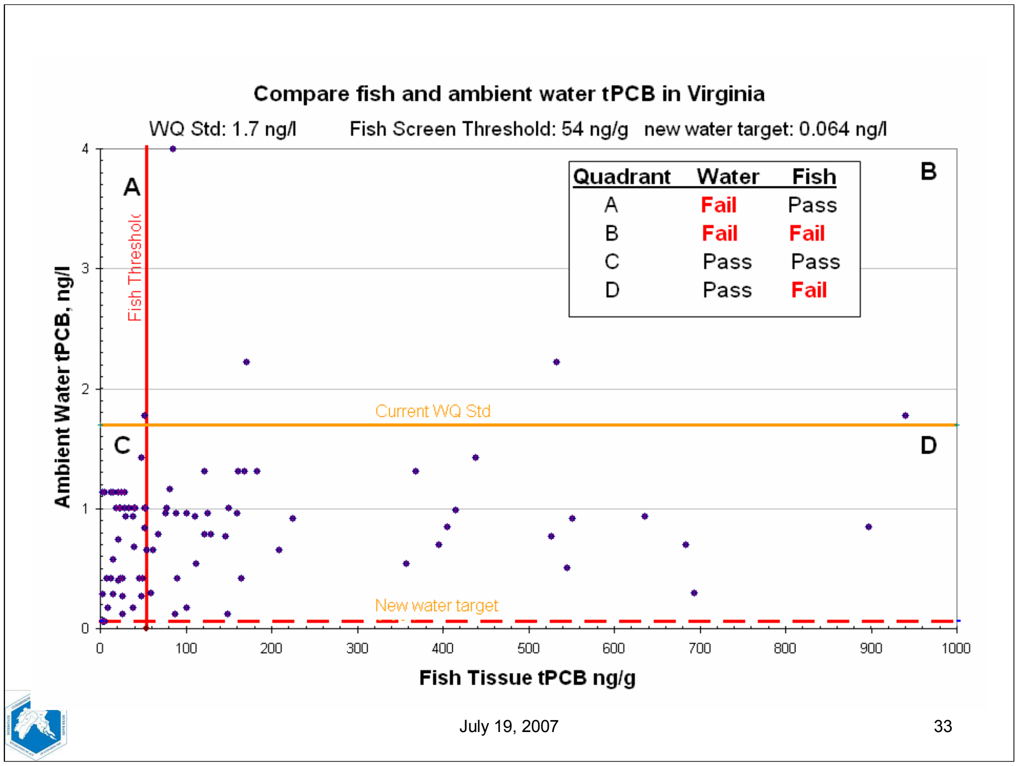
  $BAF = [PCB]_{fish} / [PCB]_{water}$
- Compute median BAF for each fish species and select species with highest BAF to protect all other species.
- $[PCB]_{water\_target} = [PCB]_{fish\_threshold} / BAF_{target}$
- Same procedure for sediment BAF.



Plots to show the relationship of water and fish data to WQS and to fish thresholds.

This figure shows the setup for the following plots

Define four quadrants of the plot space.

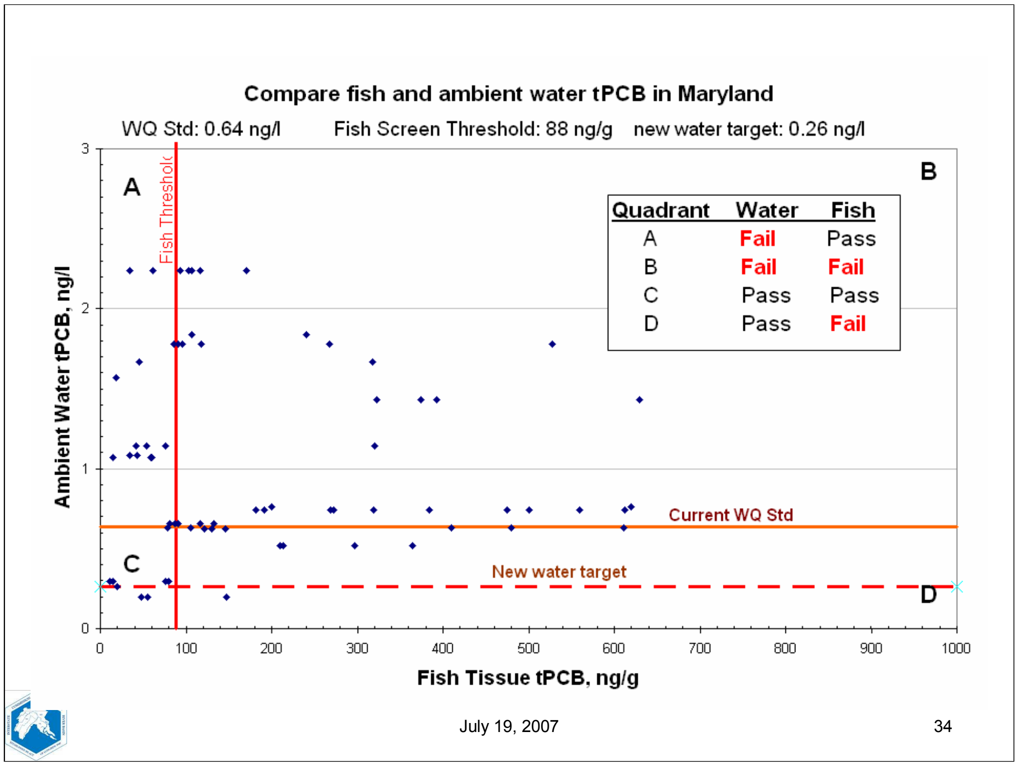


Note WQS, fish threshold, and water target numbers above plot.

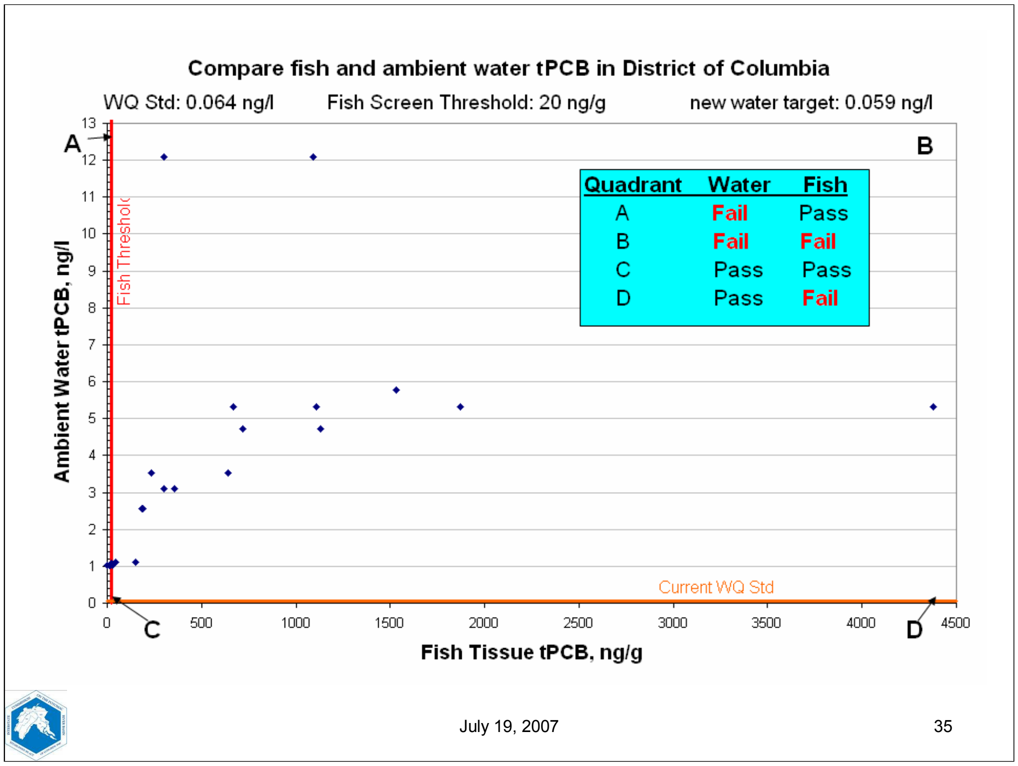
Majority of fish samples in the Virginia embayments that exceed threshold were collected in places where water samples were below WQS.

In other words, a water sample with measured value at or below 1.7 WQS does not provide assurance that the fish are OK to eat.

Note water target line at bottom of plot. A sample with measured value at or below 0.064 ng/l does provide assurance that fish are OK to eat.



In Maryland, disparity between WQS and fish threshold not as dramatic as in Virginia, but still there are fish samples exceeding the threshold but below WQS.



DC has very low WQS and slightly lower target.

Point of this plot is to show the much higher fish and water concentrations found in the District. Note the changed X and Y scales compared to previous two slides.

Summary Selecting Water / Sediment TMDL targets

- Analysis of fish and water data indicate that fish thresholds are exceeded in areas where water samples are below WQS, particularly in VA and MD.
- TMDL allocations must correct the impaired designated use, which is fish consumption.
- Therefore, TMDL water targets, calculated to be protective of fish threshold concentrations, are lower than WQS.

	WQS	Target (ng/l)
DC	0.064	0.059
MD	0.64	0.26
VA	1.7	0.064

The Potomac PCB model

Acknowledge contributions of Chesapeake Bay Program models

- Watershed model provided flows, TSS, and carbon

- Bay WQ model provided model grid, also much data for calibration

Also acknowledge that POTPCB is direct descendent of the Delaware PCB TMDL model.

The Potomac PCB Model (POTPCB)

Integrated Modeling Framework

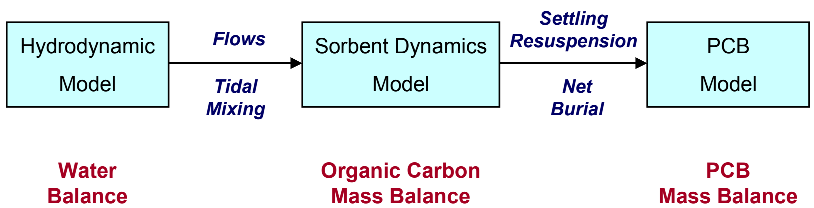


Figure 2. Integrated Modeling Framework

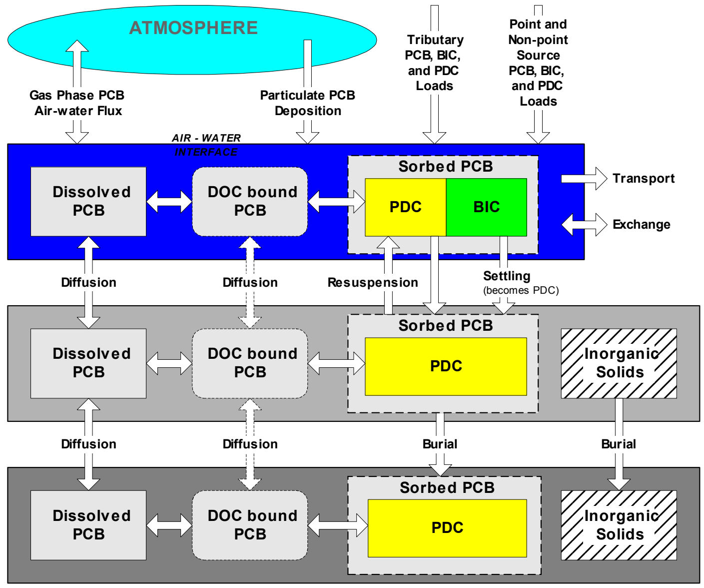
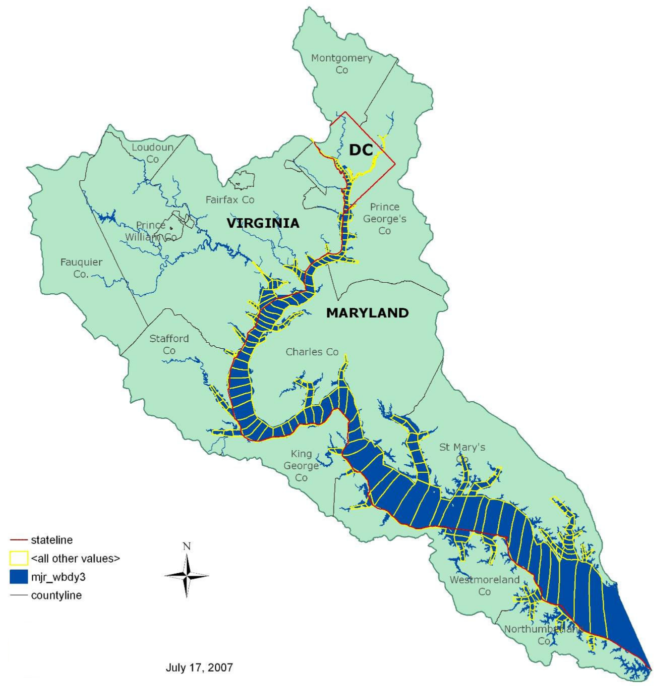


Figure 4. Conceptual Framework for PCB Model

POTPCB Model segmentation

257 segments total



Running the POTPCB model to determine TMDLs

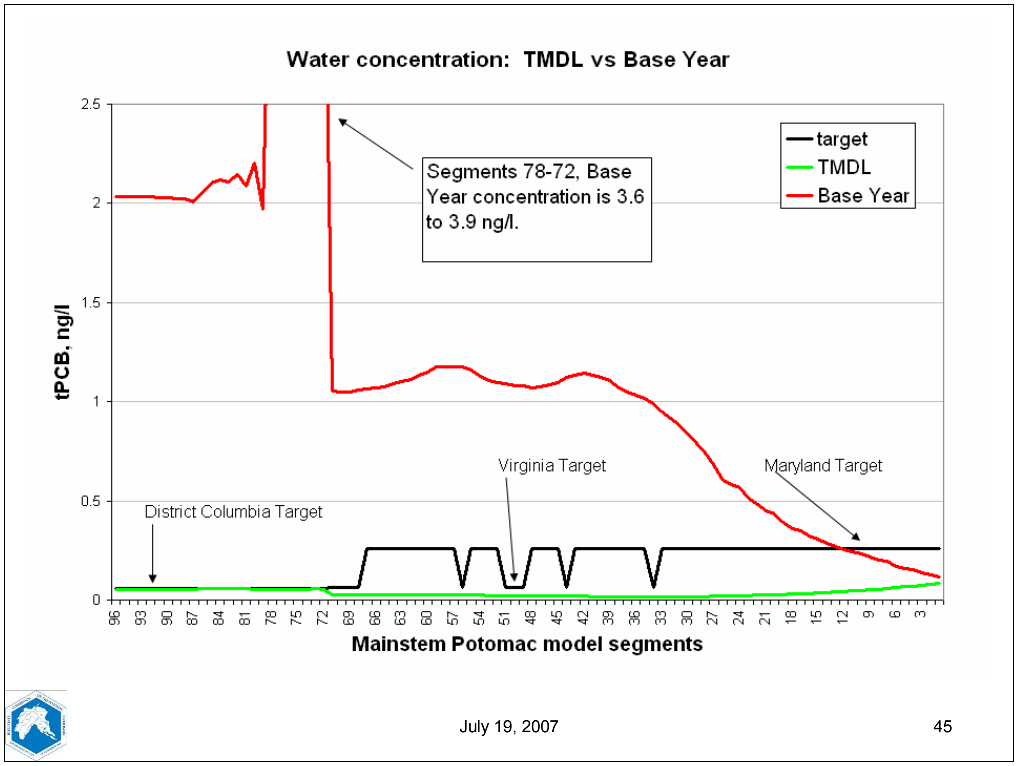
1) Model is calibrated to observed data for 2002-2005.
2) Because current sediment / water are not in equilibrium with each other, the Base Case (2005 flows, 2005 loads) condition and all scenarios (2005 flows, scenario loads) are cycled for up to 100 years to reach dynamic equilibrium.
3) Median (or highest 30-day average in DC) water and sediment concentrations in final year, for each model segment, is the value compared between scenarios and against the water target.
4) Initial "scoping" model runs indicated the approximate level of reduction required to reach target concentrations, the relative impact of each source, and where are the key points that require the largest load reductions.
5) Candidate TMDL scenarios were run with load reductions assigned to sources focusing on those key points. In iterative fashion, results from candidate scenarios were examined and adjustments made to find the combination of loads representing the maximum that would yield equilibrium concentrations at or below targets.

District of Columbia regulations require that the highest 30-day average value meet the TMDL target.

Running the POTPCB model to determine TMDLs (continued)

5) Steering Committee agreed to some "rules" to guide load allocations to sources, that included:
   a. All WWTP WLA = design flow X jurisdiction water target
   b. All atmospheric deposition receives the same % reduction
   c. Nonpoint source (direct drain) reductions are assigned by watershed/FIPS rather than to individual model segments
   d. Targets must be met in all model segments, including those not part of impaired water body.
   e. Explicit MOS, 5%, applied uniformly to all sources after TMDL amount determined
6) Once a load allocation that met targets everywhere was arrived at, TMDL equations (TMDL = WLA + LA + MOS) were computed for each impaired water body, as well as for the entire system.

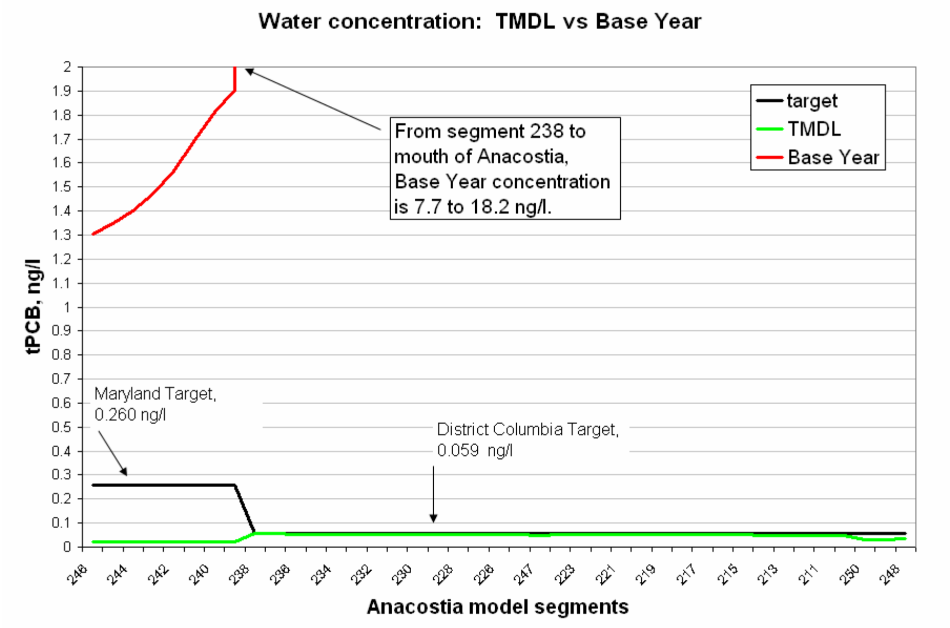
Potomac PCB TMDL Results



Water concentration results shown in four plots:

- Mainstem Potomac R. segments
- Anacostia R.
- Virginia side embayments
- Maryland side embayments

All plots arranged water flow from left to right.



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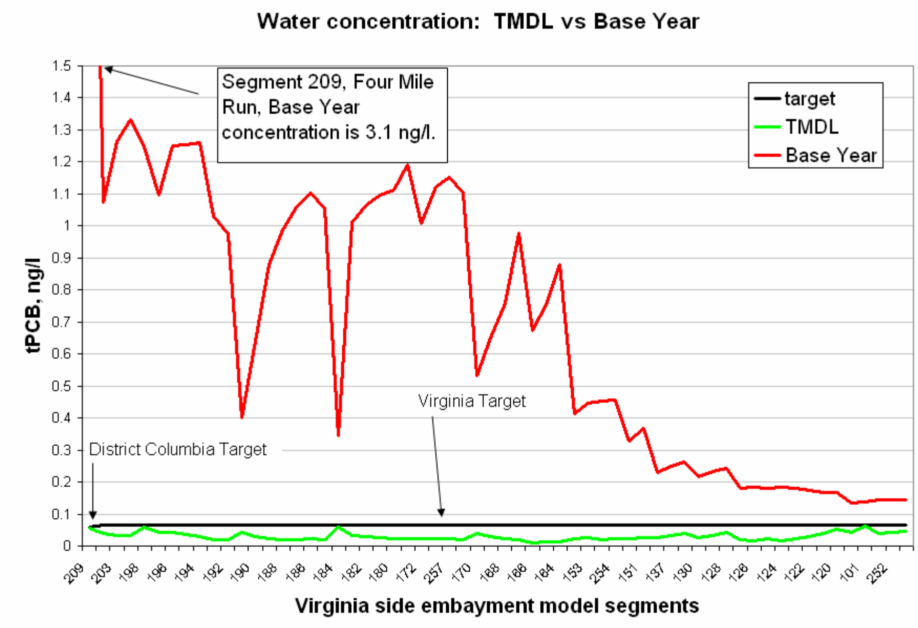

July 19, 2007

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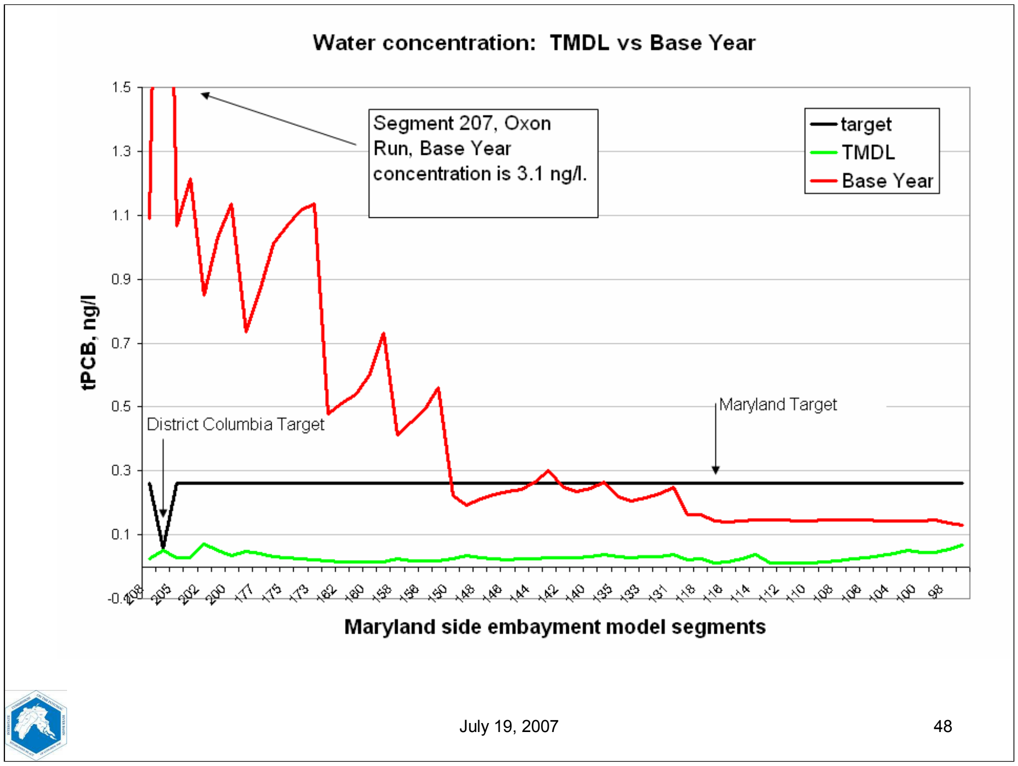
Water concentration: TMDL vs Base Year
Segment 207, Oxon Run, Base Year concentration is 3.1 ng/l.
target
TMDL
Base Year
tPCB, ng/l
District Columbia Target
Maryland Target
Maryland side embayment model segments
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TMDL Equation for entire Potomac estuary

	BASE	TMDL	Reduc
WWTP	762	64.8	91.5%
Reg. Stormwtr	9120	163	98.2%
CSO	3020	58.1	98.1%
Total WLA	12900	286	97.8%
Trib.	19300	951	95.1%
nonpoint source	1790	260	85.5%
Atmos. Dep.	3100	206	93.4%
Contam. Sites	15.1	10.3	31.8%
Total LA	24200	1430	94.1%
MOS		90.4	
TMDL	37100	1810	95.1%

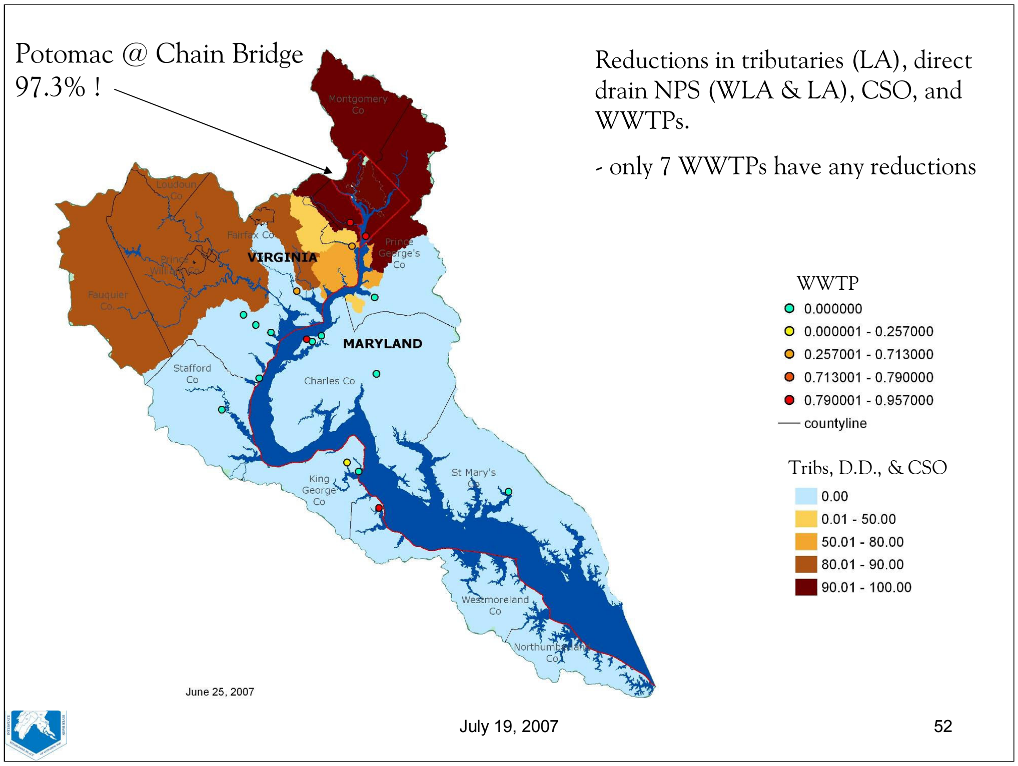
PLUS: Downstream boundary concentration reduction of 18%!

Overall Load Reductions by Source Category

Source	Base	TMDL	Reduction
Potomac @ Chain bridge	16,433	444	97.3%
Direct Drain	10,911	446	95.9%
Other Tribs	2,857	558	80.5%
WWTP	762	68	91.0%
CSO	3,022	61	98.0%
Atmos	3,072	217	93.0%
Contam	15	11	28.3%
TOTAL	37,071	1,804	95.1%

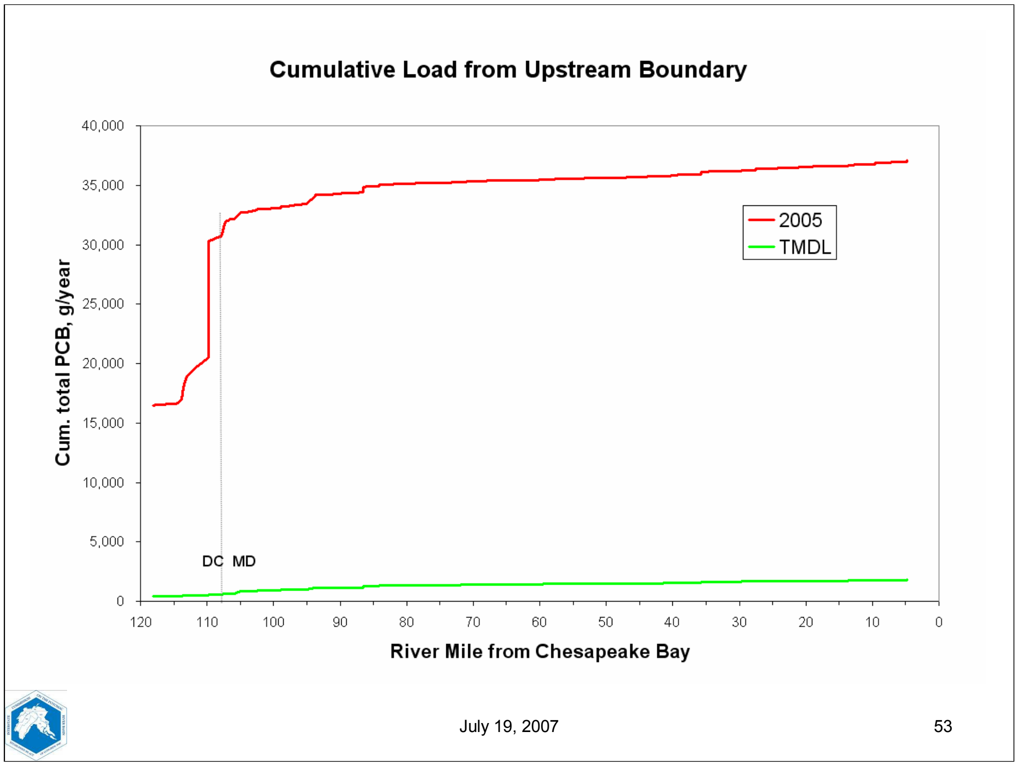
Although load reductions from preceding two tables look very severe, reductions (other than atmos dep) are concentrated in the upper end of the watershed.

Removing atmos deposition from the calculation reveals a pronounced geographic distribution of load reductions …

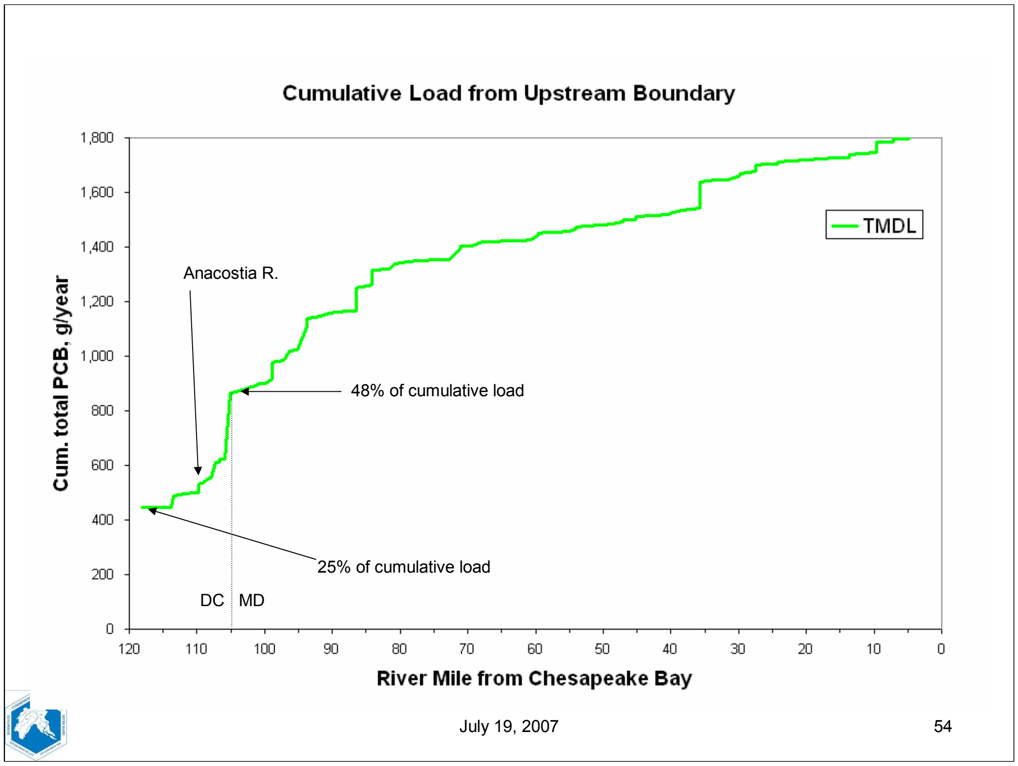


Scale for WWTPs is fraction reduction, 0 - 1

Scale for Tribs, DD, & CSO is percent reduction, 0 – 100



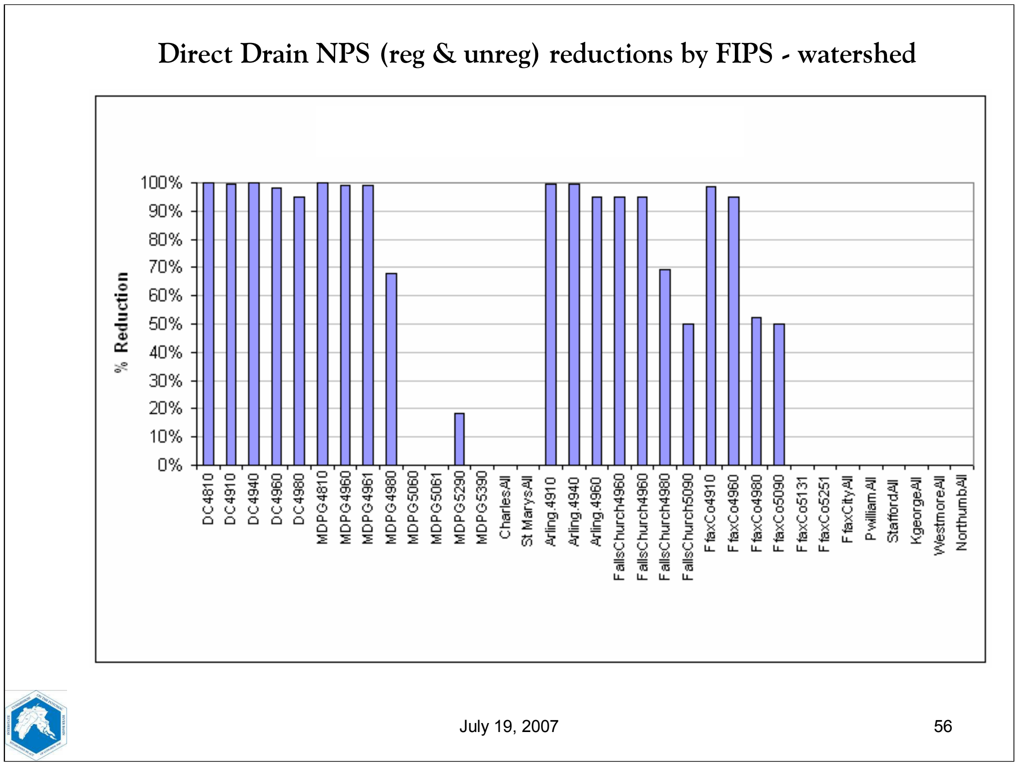
Same scale as previous cumulative load plot



Change scale in order to see structure in TMDL cumulative load line.

Tributary Reductions

Tributary	Base Year	TMDL	Reduction
Potomac R. at Chain Br.	16,433	444	97.3%
Rock Cr	727	36	95.0%
NW Br Anacostia	298	7	97.7%
NE Br Anacostia	429	10	97.7%
Upper Hunting Creek	322	161	50.0%
Upper Piscataway	29	29	0.0%
Accotink Cr	607	85	86.0%
Occoquan River	270	54	80.0%
Mattawoman Creek	39	39	0.0%
Quantico Cr	12	12	0.0%
Aquia Creek	22	22	0.0%
Nanjemoy Creek	6	6	0.0%
Wicomico / Zekiah	70	70	0.0%
St Clements Cr	7	7	0.0%
Upper McIntosh Run	9	9	0.0%
St Marys Riv	9	9	0.0%
TOTAL	19,289	1,000	94.8%



Graphic on next slide shows location of watersheds listed here.

Direct Drain watershed units in upper watershed

Facility	NPDES	Base Load	TMDL load	Reduction
BLUE PLAINS	DC0021199	643	27.8	95.7%
INDIAN HEAD	MD0020052	0.062	0.165	-166.1%
LA PLATA	MD0020524	0.243	0.495	-103.7%
NSWC-INDIAN HEAD	MD0020885	2.28	0.165	92.8%
PISCATAWAY	MD0021539	1.51	9.906	-556.0%
MATTAWOMAN	MD0021865	0.642	6.604	-928.7%
LEONARDTOWN	MD0024767	0.206	0.225	-9.2%
NSWC-DAHLGREN	VA0021067	0.0203	0.059	-190.6%
DALE CITY #8	VA0024678	0.0818	0.374	-357.2%
DALE CITY #1	VA0024724	0.1728	0.374	-116.4%
H.L. MOONEY	VA0025101	1.6585	1.953	-17.8%
ARLINGTON	VA0025143	15.5	3.255	79.0%
ALEXANDRIA	VA0025160	15.3	4.394	71.3%
NOMAN M. COLE JR.	VA0025364	15.6	5.452	65.1%
COLONIAL BEACH	VA0026409	2.71	0.163	94.0%
Dahlgren Sanitary District	VA0026514	0.109	0.081	25.7%
QUANTICO-MAINSIDE	VA0028363	0.103	0.179	-73.8%
AQUIA	VA0060968	0.193	0.976	-405.7%
TOTAL		699	62.62	91.0%

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Table shows that some facilities have a WLA larger than the estimated 2005 load. Load allocations to WWTPs were based on the “design flow X target” rule, not on a % reduction of an estimated 2005 load, so the % reduction column is not particularly relevant

Main point of WWTP allocations is that facilities do not exceed water target at end of pipe.

TMDL Summary Findings

1) VERY high reductions in all sources in DC and adjacent counties.

2) Achieving targets in DC requires 93% reduction in atmos. deposition

3) Away from Metro Washington area, required trib and NPS reductions decline to 0.

4) The Washington area reductions, plus 93% reduction in atmos. deposition, achieve necessary water quality improvement for lower part of estuary, except Coan River.

5) Coan River requires an 18% reduction in the Ches. Bay boundary concentration. This is due to influence of main Bay carried upstream for many miles in mainstem Potoamc and Coan R. Bay has wide mouth to mainstem and thus strongly influenced by mainstem concentration

6) Ratio of $[PCB]_{water}$ to $[PCB]_{sediment}$ in model results is such that achieving water target always achieves sediment target, except in a few places where both water and sediment concentrations are well below target limits.

TMDL Summary Findings (continued)

7) Although only estuary wide calculations shown in this presentation, TMDL equations were calculated specific to each impairment and can be reviewed in the draft TMDL.

8) Results show that integrated, interstate, approach to determining TMDLs for all these impairments simultaneously was necessary – each TMDL depends on its neighbor load allocations, including allocations to parts of watershed not designated as impaired.

9) Interstate cooperation to develop TMDLs was a) successful and b) may point the way for future interstate cooperation on TMDLs (Ches Bay TMDL?).

Public Comment period to August 16.

Draft TMDL and model calibration reports, public comments instructions, other documentation, are on the ICPRB website.

http://potomacriver.org/water_quality/pcbtmdl.htm

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